

**National Institute of Information and Communications Technology** 

## Asia/Oceania Space Weather Alliance (AOSWA)

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GPS receivers all over the world 5000 receiver data available online



### GPS-TEC at Sumatra island

Dense and wide-coverage GPS receiver network can reveal their spatial structures, propagation directions, and temporal evolutions.

### Current



### **Near Future Plan & Vision**



The 1st AOSWA Kick-off meeting 12/03/2010 Bandung – Indonesia Japan, Indonesia, Australia, India, and Malaysia



The main objective of the AOSWA is to make a regional linkage of information of space weather for operations and researches.

## **AOSWA** meetings



### 2010.12 - LAPAN workshop

- The first kick-off meeting between Japan, Indonesia, Australia, India, and Malaysia
- 2010.01.2 SEALION workshop @Thailand
- Indonesia, Vietnam, Taiwan, USA, Brazil, Thailand, Laos, Philippine, China and Japan
- 2<sup>nd</sup> Kick-off meeting of the AOSWA

### 2011.04 @NOAA, USA

- Space Weather Workshop @NOAA, USA & ISES meeting 2011
- Local meeting between A-O ISES countries

2011.08 - AOGS @Taiwan

- AOGS; "Collaborative Researches and Operations of Space Weather Forecasting in Asia-Oceania"
- 3rd kick-off meeting of the AOSWA

2012.02 AOSWA 1<sup>st</sup> Workshop @Chiang Mai, Thailand

• 10 countries, 25 organizations, 77 participants!

2012.08 AOGS2012 @Singapore

- Asia-Oceania Space Weather Alliance: AOSWA session
- AOSWA informal meeting

2013.11 AOSWA 2<sup>nd</sup> Workshop @Kunming, China

- 11 countries, 29 institutes, 99 participants
- Main theme: space weather research to operations

2015.03 AOSWA 3<sup>rd</sup> Workshop @Fukuoka, Japan

- 14 countries, 75 participants
- Main theme: promoting international collaboration

2016.10 AOSWA 4<sup>th</sup> Workshop @Jeju, Korea

- 16 countries, 41 institutes, 131 participants
- Main theme: the risk of space weather, regional action

## AOSWA Link

#### Issue5, March 2015 We hope the AOSWA framework helps our activities for improving space weather activities http://aorwa.nict.go.jp/

#### In this Issue...

KASI's contributions to Space Weather Kvunesuk Cho. Group leader Solar and Space Weather Group, Korea Astronomy and Space Science Institute, Korea

#### An Introduction to ANGKASA, UKM

Nurul Haiijah Hair & Mardina Abdullah Space Science Centre (ANGKASA), Institute of Climate Change, Universiti Kebangsaan Malaysia, Malaysia.

#### Internship Trainee Program at NICT Suhaila M Buhari Universiti Kebangsaan Malaysia , Malaysia

#### United Nations / Japan Workshop on Space Weather

Akimasa Yoshikawa Lecturer International Center for Space Weather Science and Education, ICSWSE Department of Earth and Planetary Sciences, Kyushu University

Domestic Collaborative Symposia supported by the Solar-Terrestrial Environment Laboratory, Nagoya University, Japan

#### Your contribution is always welcome!

If you should wish to submit an article, you are greatly appreciated. The articles should be approximately 500 words and contain either figures or pictures. Also It is available for use as a means of spreading information, such as upcoming conference and so on. Your feedback is always welcome. Contact : sw-project-office@mi.nict.go.jp

#### KASI's contributions to Space Weather over the past 10 years Kyungsuk Cho. Group leader Solar and Space Weather Group, Korea Astronomy and Space Science Institute, Korea

For the past decade, supported by the Korean government, the solar and space weather group of Korea Astronomy and Space Science Institute (KASI) has been researching towards the prevention of hazard- to store, use, and disseminate the Solar Dynamic Obous effects on Korean satellites, the stability of wire-servatory (SDO) data for the Asian region (Fig 1e). The less telecommunications, and the safety of polar SDO center has three subsystems; the first is the data route aviation. So far, we have collaborated with NJIT transfer system (DTS) to transfer SDO data from Stanand NASA, and established a Space Weather Predic- ford University to KASI via the 10 Gbps GLORIAD nettion Center, with which we have been developing a work. The second is the data archive system (DAS) to more advanced models for space weather forecastine, archive and manage JP2 data (30 TB since 2010, Sep.) Aloneside that, we have continued our research on solar activities and the Sun-Earth connection. which was designed in consideration of the compati-

tory respectively. In 2007, the group started a new space weather project to establish a Korean Space Weather Prediction Center (Fig1c). The scope of the project included the extension of the ground observa- of developing the sciences, services, and technologies tion system, the construction of the space weather of space weather. We believe, based on our experidatabase, and the development of prediction models. ences over the past 10 years, that we may contribute Through the project, several space weather products to the future advances of AOSWA. have been developed, and forecasting services have been provided to a satisfied domestic clientele such as Korean Air (Fig1d).



In 2010, KASI turned its main scientific focus to space observation. As a part of the efforts, KASI made an agreement with NASA to set up of the data system and Fits data (800 TB since 2012, March) of SDO. bility and scalability of the system so that we can ex-In 2004, KASI initiated a solar project with NJIT, the tend its capacity and performance at any time by add-New Jersey Institute of Technology. The project, con- ing more storage and cluster gateway, respectively. sisting of two parts, involved the development of the We hope that we will be able to provide free and un-Korean Solar Radio Burst Locator, Korea's first solar fettered access to the SDO for the AOSWA community telescope to be able to locate position of radio bursts after developing of various applications for data guar-(KSRBL, Fig1a), and the construction of 1.6 m New So-ry and analysis for space weather. KASI built a 7-meter lar Telescope, the world's largest solar optical tele- parabolic antenna in 2012 to receive space weather scope (NST, Fig1b). The project was completed in ear- broadcast data from the Van Allen Probes (VAP) misly 2009. The KSRBL and NST have been installed the sion (Fig 1f). KASI utilizes the VAP real time data to following year at KASI and the Big Bear Solar Observa- forecast space weather, protecting national space assets from severe space environment.

KASI pursues international collaborations in hopes



### UNISPACE+50

- UNISPACE+50 marks the fiftieth anniversary of the first UNISPACE conference and take stock of the contributions to global space governance of the previous three UNISPACE conferences.
- The Committee on the Peaceful Uses of Outer Space (COPUOS) at its fifty-eight session in June 2015 endorsed a plan of work (A/AC.105/L.297) for UNISPACE+50 to be undertaken by the Office for Outer Space Affairs, the Committee, and the subsidiary bodies of the Committee.
- In order to guide preparatory work for UNISPACE+50, in June 2016 COPUOS identified and agreed on seven thematic priorities, as well as their objectives and mechanisms (/71/20)
- Thematic Priorities
  - 1. Global partnership in space exploration and innovation
  - 2. Legal regime of outer space and global space governance: current and future perspectives
  - 3. Enhanced information exchange on space objects and events
  - 4. International framework for space weather services
  - 5. Strengthened space cooperation for global health
  - 6. International cooperation towards low-emission and resilient societies
  - 7. Capacity-building for the twenty-first century







# Activities of AOSWA members (extracted)

# Activities for Capacity building in NICT

- NICT has been holding "Space Weather Users forum" since 2003.
- Recently we had the forum at the national science museum since 2016.
- In the latest meeting, Three guest speakers presented impressive topics about amateur radio operation, space weather information in ancient documents and space sightseeing. After the forum we had a small tour in the museum for braising space weather exhibition.
- NICT has a internship fund which pays to students the travel fare to NICT and staying expense.
- In FY2013, we received two students from Korea for one month (Jan.).
- In FY 2014, we received one student from Malaysia, and several people will visit from Indonesia on August for few days.
- In FY 2015, we prepared a full program for learning operational space weather forecast and received two students from ANKGASA, Malaysia





### Impact of Space Weather on Earth COSPAR Capacity Building Workshop August 15 – 26, 2016, Paratunka, Kamchatka (Russia)

The workshop on space weather was held at the Institute of Cosmophysical Research and Radio Wave Propagation of the Far Eastern Branch of the Russian Academy of Science (IKIR FEB RAS)

IKIR FEB RAS was presented the methods for system analysis, GPS and low-orbit radiotomography of the ionosphere, radiosounding of the magnetosphere, lidar sounding of the ionosphere. The International Heliophysical Year 2007 facilitated the development of ground observation systems and the coordinated investigation of space weather impacts on the Earth. As a result of international cooperation within the MAGDAS and INTERMAGNET Programmes, observation system complexes were created in the Far East during that time. Analysis of data produced by these observation systems was form a key element of the programme of study proposed.



### Major Solar Radio Facilities at Mingantu Observing Station, **NAOC for Space Weather**

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40 m



### **Mingantu Spectral Radioheliograph** (MUSER)

**MUSER: Two arrays with 64 channels in** 0.4-2.0 GHz & 520 channels in 2.0-15 GHz, space resolution: 1.3<sup>"-50"</sup>, and time resolution: ~100 ms.

### **Monitor solar eruptions** from the Sun to the Earth "

Future plans in next 5 years: to build a new array of 100 LPDA + calibration element covering 30-400 MHz. to build a new 3-station IPS telescope @327/654 MHz: **Mingantu IPS Main Station** with  $3 \times 140$  m (NS) $\times 40$ m(EW) cylinders; Two substations with ~Φ15m

antennas.





### Australian Government

Bureau of Meteorology

SWS continues to engage with industry and the general public. Recent activities include state and national risk assessment scenarios based on extreme space weather events with owners and operators of critical infrastructure. In December 2015, SWS held its inaugural Space Weather Users workshop with over 100 participants from industry and the general public. These are a bi-annual event. In November last year, the second workshop was held following the Australian Space Research Conference (





## Present and future stream of AOSWA

- Many of Asian countries are aware of the importance to measure space weather and are interested in working for space weather service.
  - LAPAN, Indonesia has operated space weather forecast service as an RWC of ISES since 2015.
  - ANKGASA, Malaysia sent two staffs to NICT to train the skill of space weather forecast service in 2015.
  - KMITL, Thailand is now preparing space weather forecast briefing room in their campus.
- A decade ago the ground based observatories had clustered on developed countries. Now we are on the phase to spread the points all in Asia-Oceania region.



Training of SWx forecast to Malaysian staff



Space Weather forecast by LAPAN, Indonesia

## Present and future stream of AOSWA

- Japanese GNSS satellites "Michibiki" series will start the positioning service in 2018 with 4 vehicles and finally with 7 in 2023.
- The visible satellite number will be maximum in Southeast Asia and Oceania. Many commercial companies seek business opportunities in the region using GNSS information.
- However, in this area, some specific ionospheric disturbances often occur in spring and autumn which affect on the precision of GNSS.

The monitoring and forecast of SWx and ionosphere become more important than ever.







### Hot spot of positioning satellites



### Plasma bubble model (Yokoyama et al., 2015)

## **Summary and Conclusions**

- It is eagerly required to estimate the quantitative social impact of SWx.
- Some national governments (e.g., US, UK, Korea), international organizations (e.g., ICAO), and private companies (e.g., Lloyd) reported documents related to SWx disaster and mitigation.
- NICT has been operating space weather forecast since 1988 and improving the precision of the forecast using cutting-edge technology.
- The framework of space weather services has been assigned in the thematic priorities of UNISPACE+50. This frame work should be required also in the operation of ICAO space weather centers.
- Many of Asian countries are aware of the importance to measure space weather and are interested in working for space weather service. A decade ago the ground based observatories had clustered on developed countries. Now we are on the phase to spread the points all around the world.
- We need to discuss the necessary tasks and strategy how we drive the stream, for example, presentation to the decision-maker of the budget, education for glow up the next generation researchers/operators, framework of data sharing etc.

# Thank you very much!